

Module 4 - Strain Gauges

ME3023 - Measurements in Mechanical Systems

Mechanical Engineering
Tennessee Technological University

Topic 1 - Measuring Strain

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- Motivation in Design
- Stress and Strain
- The Strain Gauge
- Engineering Applications

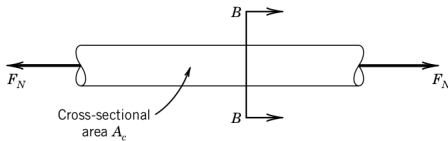
Motivation in Design

The design of load-carrying components for machines and structures requires information concerning the **distribution of forces within the particular component**. Proper design of devices such as shafts, pressure vessels, and support structures must consider **load-carrying capacity and allowable deflections**. Mechanics of materials provides a basis for predicting these essential characteristics of a mechanical design, and provides the fundamental understanding of the behavior of load-carrying parts. However, theoretical analysis is often not sufficient, and **experimental measurements** are required to achieve a final design.

Text: Theory and Design of Mechanical Measurements

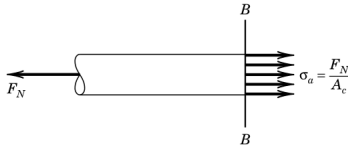
Stress and Strain

Consider a member under uni-axial loading. The **strain** is defined as the ratio of the change in length to the original length of the component.



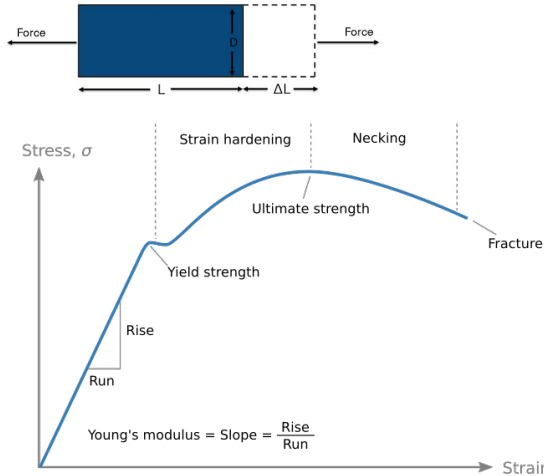
$$\sigma_a = \frac{F_N}{A_c}$$

$$\epsilon_a = \frac{\delta L}{L}$$



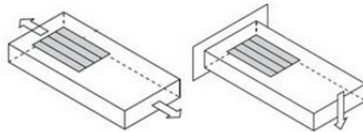
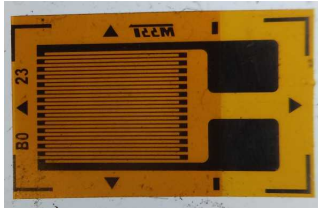
$$\sigma_a = E_m \epsilon_a$$

Stress and Strain



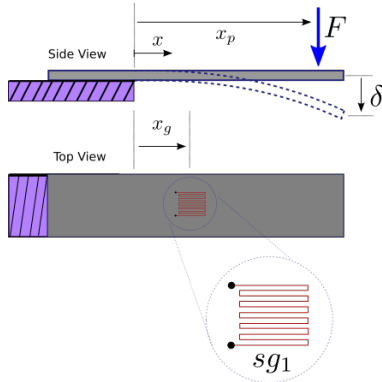
The Strain Gauge

... the ideal sensor for the measurement of strain would (1) have good spatial resolution, implying that the sensor would measure strain at a point; (2) be unaffected by changes in ambient conditions; and (3) have a high-frequency response for dynamic (time-resolved) strain measurements. A sensor that closely meets these characteristics is the **bonded resistance strain gauge**.



The Strain Gauge

Strain gauges can be mounted in different ways for different purposes. We will begin with a single gauge mounted in the axial direction.



Engineering Applications

- Segway back to *Motivation in Design* (Slide 1) ...
- Aerospace
- Infrastructure
- Please read this article [here](#). We will cover the mathematics and theory in class but this article has a short section on applications of strain gauges that I want you to see.